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Carper Sand Oil Production in St. James, Wilberton, and St. Paul Pools, Fayette County, Illinois

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CARPER SAND OIL PRODUCTION IN ST. JAMES, WILBERTON, AND ST. PAUL POOLS, FAYETTE COUNTY, ILLINOIS

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ABSTRACT

The discovery of oil in the early Middle Mississippian Carper sand in Wilberton pool, Fayette County, Illinois, late in 1961, prompted additional successful drilling to that zone. This report illustrates the structural and stratigraphic features that control the occurrence of oil in the Carper sand at Wilberton pool and adjacent pools to the north and south.

A cross section and an isopach map show the Carper of this area ranging in thickness from zero to over 100 feet. Photomicrographs of thin sections illustrate the extremely fine-grained nature of the Carper sand.

Production figures on the three pools studied show that appreciable quantities of oil have been produced from this fine, tightly cemented sand after fracture treatment.

Further exploration of the Carper sand is justified and should be based on regional studies of the Borden Siltstone to find structural and stratigraphic traps developed in the Carper.

INTRODUCTION

Oil was discovered in the area of St. James, Wilberton, and St. Paul pools in 1938. Until recently this oil was produced from rocks of Chesterian and upper Valmeyeran age. Interest in the area was renewed by the discovery of oil in the lower Valmeyeran Carper sand late in 1961.

This report points out the significant factors controlling Carper production in the three pools studied. The older, shallower production will not be discussed in any great detail and only holes that reached the Carper sand are shown on the accompanying maps.

The data used in preparing the maps and cross sections included in this report are from records on file at the Illinois State Geological Survey. Electric logs were the primary source of information, but gamma ray, neutron, and sonic logs were used in a few cases where electric logs were not run.

The core analysis data and material for thin sections used in this report were supplied by Geo-Engineering Laboratories of Mt. Vernon, Illinois.

All completion data, including initial production, are given as reported by the operator to the Survey or to one of the commercial scouting services operating in Illinois.

LOCATION

The report area lies along the western margin of the Fairfield Basin and includes most of T. 5 and 6 N., R. 2 and 3 E., Fayette County, Illinois. Figure 1 is an index map relating the report area to the major geologic features in Illinois and the surrounding states.

Fig. 1 - Index map showing geologic setting of report area.

STRATIGRAPHY

The name Carper sand was first applied in 1926 by G. F. Moulton to a producing sand in Martinsville pool, Clark County, Illinois. It was described as "a fine grained sandstone which occurs in lenticular bodies of considerable areal extent in the black shale underlying the Mississippian limestone." Since it was first used, the name Carper has been generally applied to the sandstones and sandy siltstones that occupy the lower portion of the Borden Siltstone. These sandstones, although they cover large areas in some cases, are not continuous, and the correlation of the several bodies of "Carper" throughout Illinois has yet to be accomplished.

The electric log in figure 2 illustrates the typical stratigraphic sequence tested by holes in the report area. The Carper sand, where present, lies near the base of the Borden Siltstone with about 20 to 50 feet of shale separating it from the Chouteau Limestone. The Chouteau is considered to be the uppermost unit in the Kinderhookian Series (Workman and Gillette, 1956), which places the Carper within the Valmeyeran Series.

The Borden Siltstone is a deltaic deposit extending in a tongue-like body across east-central and southwestern Illinois with the source of sediments far to the northeast (fig. 3). The basic elements of a delta have been determined through regional correlations of electric logs over a large area in Illinois. A distinct division of topset, foreset, and bottomset beds has been made in this manner (Frund, 1953). The Carper exists as a sandy facies within the generally finer grained clastics comprising the bottomset beds of this delta.

The variation in thickness of the Carper sand is shown on the isopach map in figure 4. Two contiguous, elongated, lenticular bodies of Carper—one over St. James pool, the other over both Wilberton and St. Paul pools—have an apparent northwest to southeast orientation. Studies over a larger area show that this direction of orientation does not apply to other lenses of Carper. The random orientation of these lenses could be the result of the variety of directions taken by turbidity currents, which flowed down the scalloped foreset slopes of the Borden delta and served as the transporting medium for the Carper.

The Borden Siltstone is bounded on the northwest by light colored crinoidal Valmeyeran limestones typified by the Burlington and Keokuk Formations, and on the southeast by dark siliceous limestones.

The relation of the Carper sand to the Borden Siltstone can be seen in the north-south stratigraphic cross section extending southward from near the southern end of Louden pool, through St. James, Wilberton, and St. Paul pools (fig. 5). The datum for this section is the top of the Chouteau Limestone.

STRUCTURE

The three pools in the report area lie in a north-south line along a belt of positive folding that includes the Louden and Salem anticlines. Figure 6 shows the structure on top of the Carper sand. St. James pool is located on the crest of a southward plunging anticline, with Wilberton pool farther to the south on the nose of the St. James structure. The St. James fold is slightly asymmetrical with the steeper limb on the west. St. Paul pool is located on a separate nearly circular dome farther to the south.

Nearly 40 feet of reversal can be proved at the north end of the St. James structure on the top of the Carper, but lack of control prevents an exact determination.

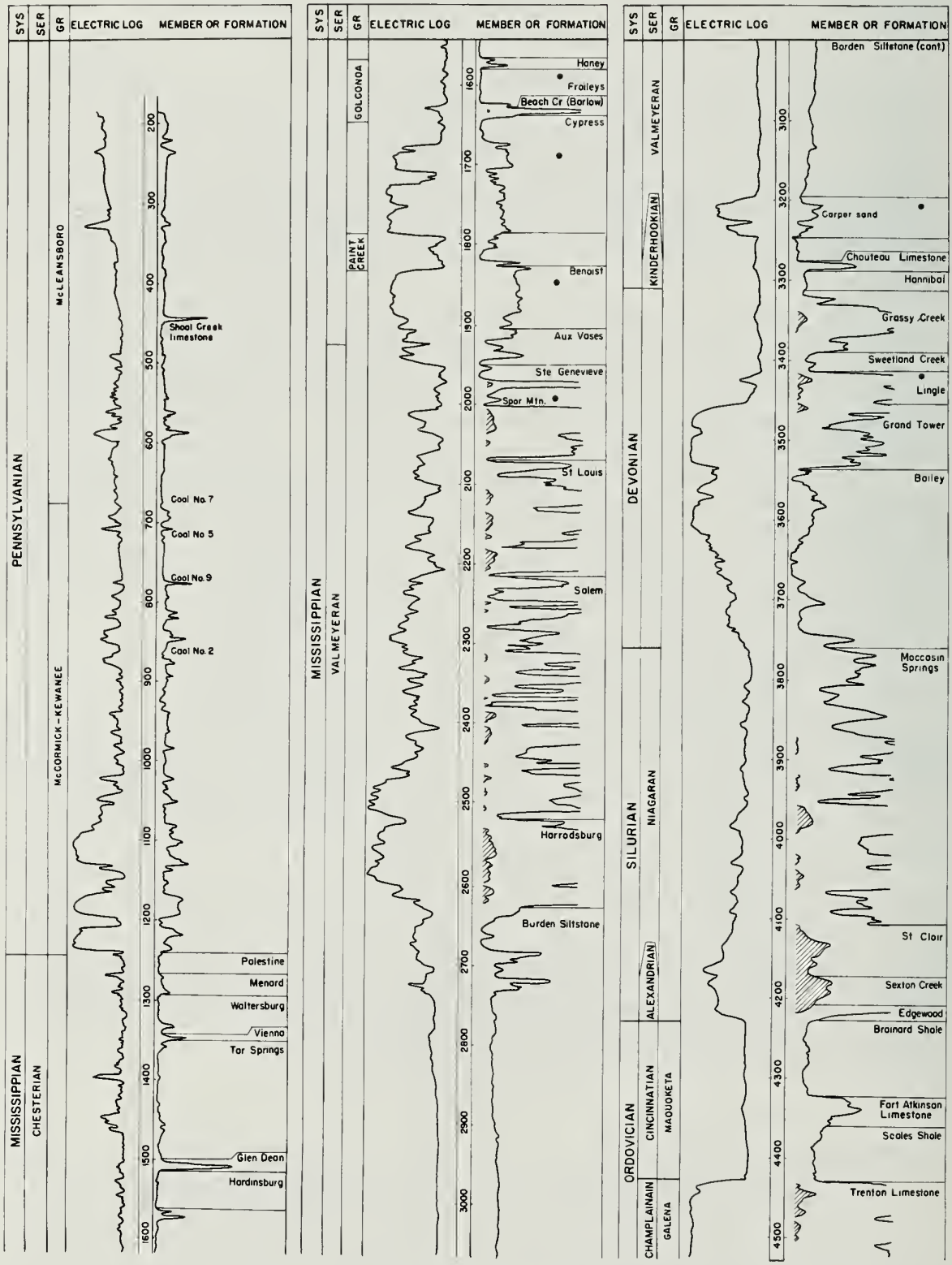

Fig. 2 - Geologic column and typical electric log with dots indicating pay zones. The electric log used is from the Kewanee Oil Co. No. 1 Gehle, section 13, T. 5 N., R. 2 E., Fayette Co., total depth 4528 feet.

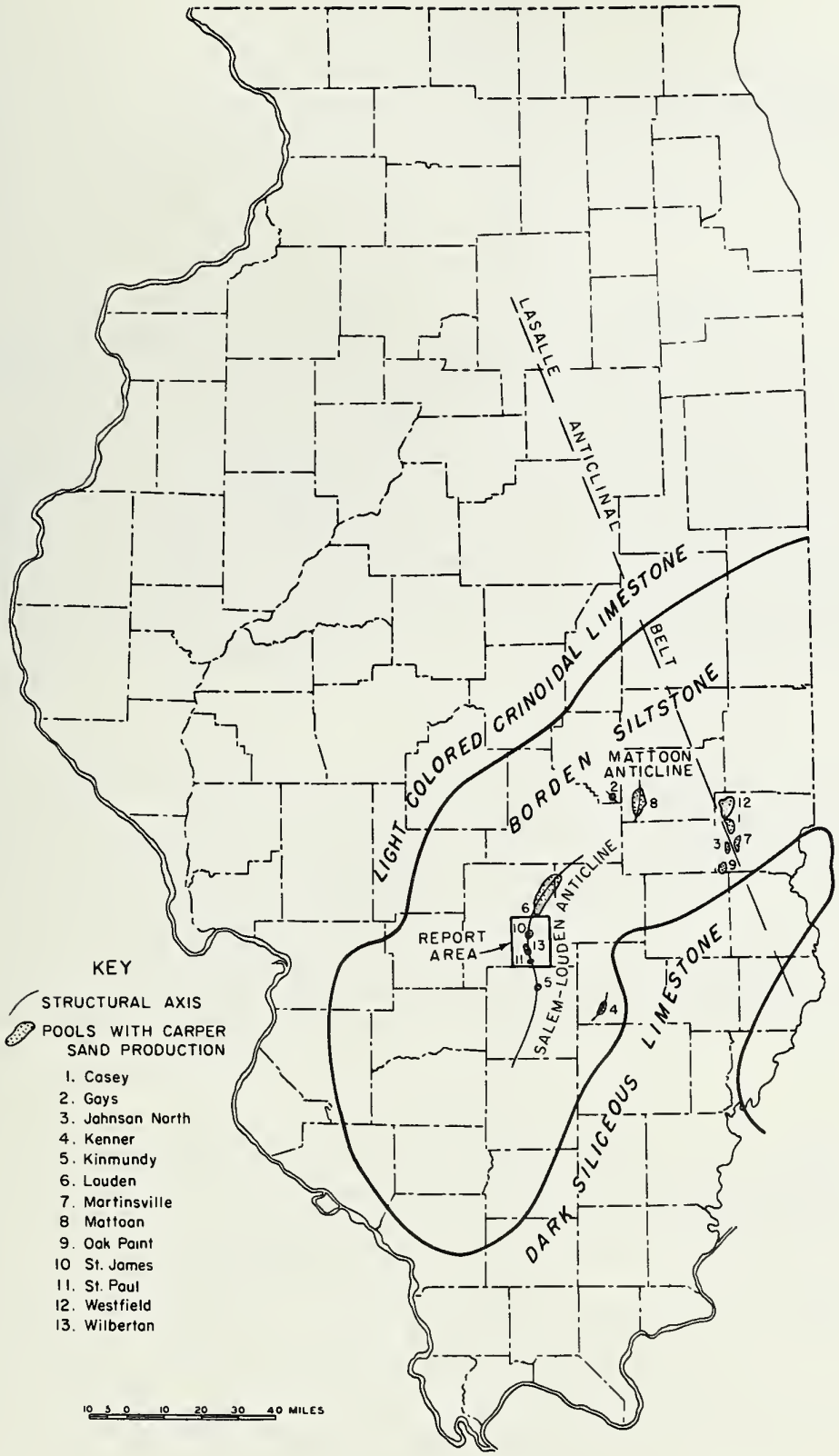

Fig. 3 - Map showing areal extent of Borden Siltstone, pools producing from the Carper sand, and axes of associated structures.

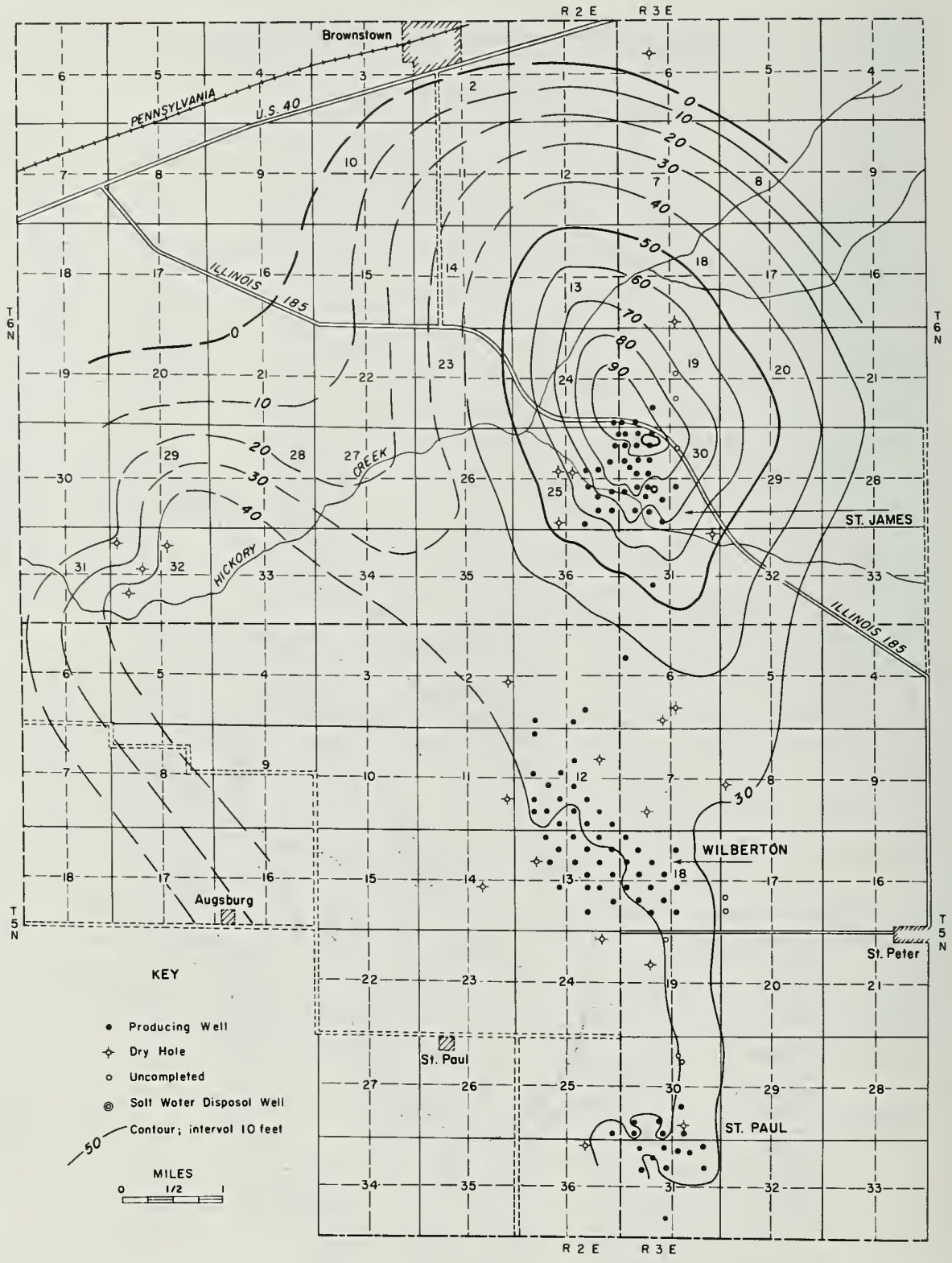

Fig. 4 - Isopach of the Carper sand.

OIL PRODUCTION

The amount of oil produced by the Carper sand is impossible to determine because the available production figures are classified by leases that, in many cases, contain wells producing from other horizons. The following summary compares some of the significant totals, indicating the production capacity of the Carper pay in the report area. Production figures were available through October, 1963.

St. James Pool

From discovery in 1938 to the end of 1961, Golconda, Cypress, Bethel, and Spar Mountain pay zones produced 15,483,000 barrels of oil in St. James pool. During that time, 209 wells were completed with 138 still producing in 1961.

Carper production was initiated in December, 1961, by the completion of the Ostrum, No. 1-A Smail well in sec. 25, T. 6 N., R. 3 E., which pumped 130 barrels of oil and 30 barrels of water per day. Additional drilling in the field during 1962 brought the total number of producing wells to 172 of which 15 were completed in the Carper pay. By the end of 1962, the accumulated production increased by 449,000 barrels bringing the total to 15,932,000 barrels. This represented an increase of about 120,000 barrels per year over the 1960 and 1961 totals. A large part of this increase was probably a result of the new pay. By November 1, 1963, the total accumulated production had reached 16,437,000 barrels.

St. Paul Pool

Benoist and Spar Mountain oil was discovered in St. Paul pool in 1941. At the end of 1961, only 10 of 18 wells were still producing, and the entire field averaged only 27 barrels per day. The accumulated production at that time was 619,000 barrels. During 1962, another 65,000 barrels were produced. In February, 1963, the Shell Oil Company completed the No. 1 C. C. Ford in sec. 31, T. 5 N., R. 3 E., for an initial production of 140 barrels of oil and 59 barrels of water from the Carper. By December 31, 1963, 18 wells had been completed as Carper producers. Production from the St. Paul pool during the first 10 months of 1963 was 96,000 barrels bringing the total accumulated production to 780,000 barrels.

Wilberton Pool

Oil was first discovered in the Middle Devonian Lingle Formation in 1959. By the end of 1960, two wells had produced 19,000 barrels from that pay.

In November of 1961, W. L. Belden drilled the No. 2 Gehle well in sec. 13, T. 5 N., R. 2 E. This was a 3476 foot Lingle test and a $2\frac{1}{2}$-hour drill stem test of the bottom 10 feet recovered 600 feet of gas and 65 feet of slightly oil cut mud. Four-inch casing was set to 3470 feet and perforated opposite the Carper with 52 shots from 3203-3242 feet. After the well was cleaned out to the total depth, it pumped 66 barrels of oil and an estimated 20 barrels of water per day. There is no way of determining how much, if any, of this oil was contributed by the Lingle. Four Carper wells were completed during 1961 and accumulated production for the field reached 111,000 barrels by the end of the year.

There were 43 wells in the field by the end of 1962 that had accumulated 494,000 barrels of oil. The bulk of this oil was undoubtedly from the Carper because

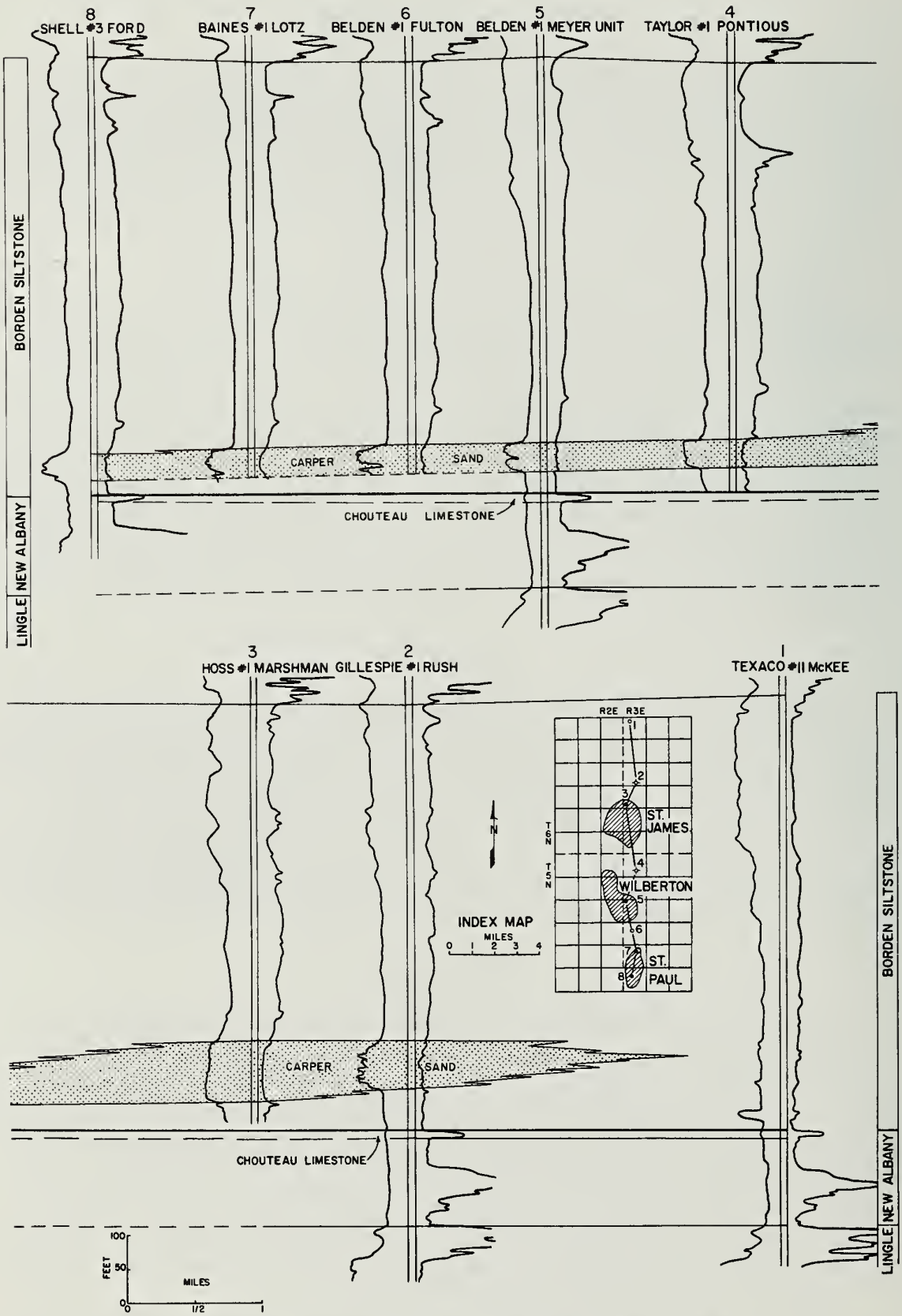

Fig. 5 - Stratigraphic cross section showing relation of the Carper sand to the Borden Siltstone.

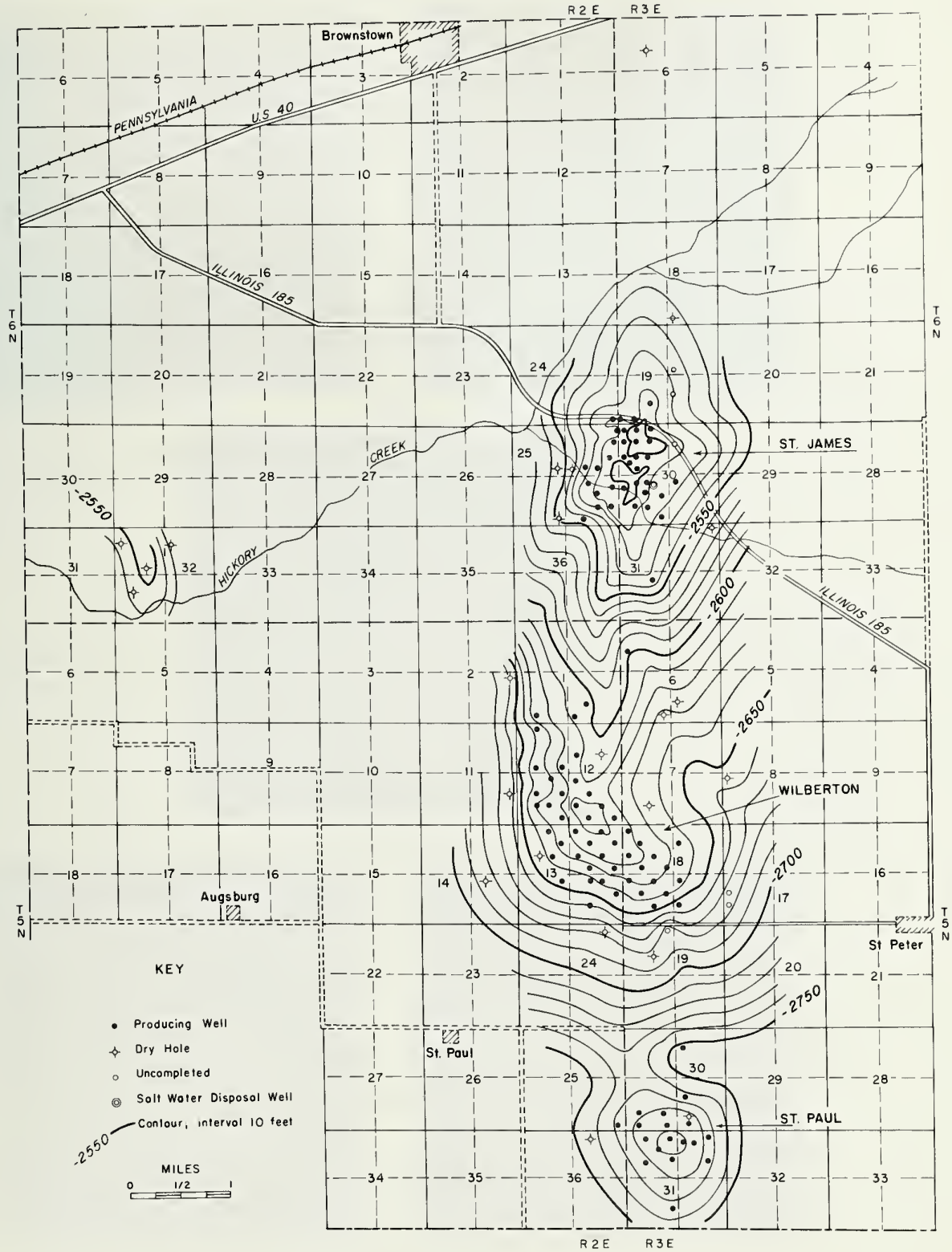

Fig. 6 - Structure map of the top of the Carper sand.

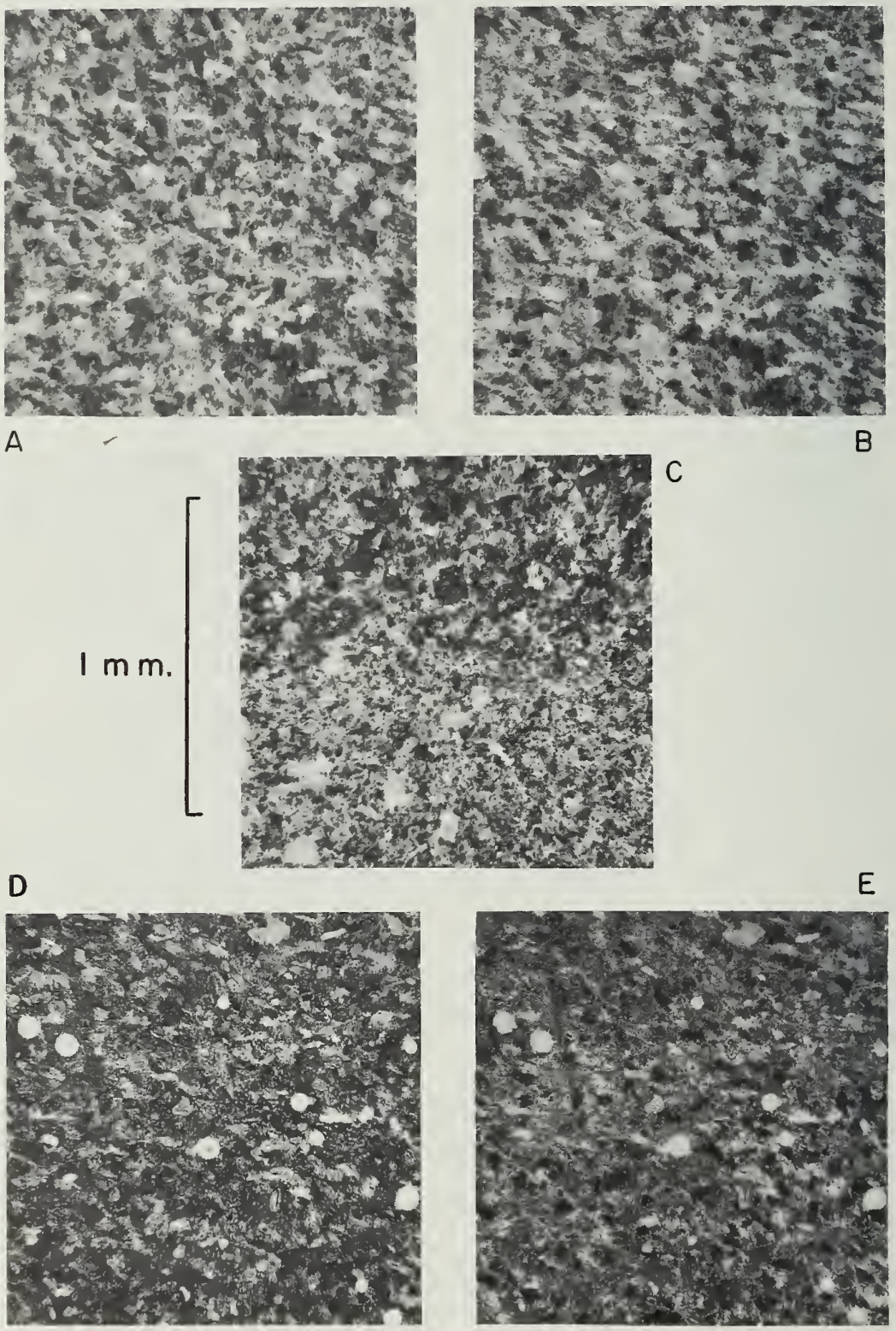

Fig. 7 - Photomicrographs of Carper sand thin sections.

the two original Lingle wells produced only 15,000 barrels during 1960, averaging about 20 barrels per day per well. Assuming that the Lingle wells were producing at nearly this rate in December of 1962, we can conclude that the 41 Carper wells accounted for slightly less than 900 of the 934 barrel daily average of the field. This amounts to a little over 20 barrels per day per well. In October of 1963, 13,000 barrels of oil were produced bringing the accumulated production to 687,000 barrels.

COMPLETION PRACTICES

The wells completed in the Carper in this area were drilled with rotary tools. Casing was set through the entire Carper section. After perforating the casing, most operators treated the pay with mud acid. In nearly every well, the Carper was fractured with several thousand gallons of water carrying several thousand pounds of sand. In a few cases, walnut hulls and occasionally salt were used in the fracture treatment.

Drill stem testing of the Carper is rare in this area and does not appear to give a good indication of the well's producing capacity where such tests were made.

RESERVOIR CHARACTERISTICS OF THE CARPER

The Carper section in Fayette County, Illinois, is commonly sandy siltstone rather than sandstone. Figure 7 shows the photomicrographs of thin sections made from cores of producing wells in St. James and St. Paul pools. These thin sections were cut at right angles to the bedding planes and have been magnified about 40 times in the photographs.

The two minerals that can be seen easily in these photographs are quartz (clear, anhedral grains) and dolomite (cloudy interstitial material and subhedral rhombic crystals). Glauconite or chlorite is fairly abundant in the Carper but is recognized only by the green color and, therefore, can not be seen on black and white photographs. Minor amounts of opaque iron minerals appear as very small black specks on the photographs. The circular black spots in D and E are air bubbles, and the large, irregularly shaped black areas in C are portions of the thin section lost in grinding. A and B are views of the same section from a St. James pool well with the nichols uncrossed in A and crossed in B. D and E are similar views of a section from a St. Paul pool well. C is from a different part of the same well as D and E and illustrates the abruptness with which the grain size and dolomite content can change. The solubility of these two St. Paul samples was tested in hot, concentrated hydrochloric acid. The core from which the thin section in D and E was made was 11 percent soluble and that from which C was cut was 43 percent soluble.

Core analyses determined a porosity range from slightly less than 3 percent to a little over 20 percent in the Carper at both St. James and St. Paul pools. Average porosities from 13 to 18 percent are common in the productive portions of the Carper. The average permeability is only about one millidarcy. No cores or core analyses from Wilberton pool are available.

FUTURE DRILLING

The limits of Carper production within the report area are fairly well defined by dry holes along the east and west margins of all three pools. This is also true on the north edge of St. James pool, on the south edge of Wilberton pool, and on both the north and south edges of St. Paul pool. A distinct separation between St. James and Wilberton pools has not been established. The dry hole in sec. 12, T. 5 N., R. 2 E. is a Devonian test prior to the discovery of Carper production. The hole in the SW SW SE sec. 1, T. 5 N., R. 2 E. (fig. 6) was drilled to the Carper but was completed in a sandy zone at the top of the Borden Siltstone. The northeast offset to this well, however, was completed in the Carper. The hole in the NW SW NW sec. 6, T. 5 N., R. 3 E. was drilled as a Carper test, and an attempt was made to complete the well in that zone. The attempt failed and the hole was abandoned. It later was worked over and a second attempt at completing in the Carper failed. A third operator attempted to complete the well, first in the Carper and then in the sandy zone at the top of the Borden Siltstone. According to the operator, the well was completed as a producer, but the pay and initial production are unknown.

In view of this inconclusive evidence of a distinct separation between St. James and Wilberton pools, the possibility of additional Carper production in that area presents an interesting possibility for exploration by further drilling. The apparent continuity of sandstone and the absence of any reversal of dip suggest that a continuous oil reservoir may exist between the two pools.

Oil shows were encountered in the Carper in three holes drilled in sec. 32, T. 6 N., R. 2 E. These holes appeared to be on the nose of a structure that is not clearly defined. Additional drilling in the vicinity of these holes would be required to evaluate the significance of the oil shows.

A regional stratigraphic study of the Borden Siltstone should precede any large scale exploration program for Carper oil. This would define the areas in which the Carper exists and is likely to develop sufficient thickness and areal extent to justify further testing. The most likely areas for oil accumulation are those places where the sand development occurs over anticlines. This condition appears to exist in the areas where the Carper is currently producing (fig. 3).

Stratigraphic traps could occur in areas where the Carper sand grades laterally into the dense silty shale of the Borden Siltstone.

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